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SUMMARY

Calibrations of two static-pressure systems were determined by a low-level flyover method, in which a ground-based camera was used, and by a high-altitude method based on pressure-altitude surveys of the atmosphere, in which a ground-based radar was used. The test airplane was a large turbojet transport. The static-pressure systems for which the calibrations were determined were a fuselage vent system and a boom-mounted pitot-static tube installed above and forward of the pilot's compartment. The calibration of the pitot-static tube showed that the position of the tube of this installation was unsatisfactory for the measurement of static pressure because the errors at both sea level and 25,000 feet were large and because the variation of the error with Mach number was also large.

The results of the tests indicated that the maximum probable error (3 standard deviations) of both low- and high-altitude calibrations of the fuselage vent system was about 1 pound per square foot, or 12 feet at sea level and 30 feet at 25,000 feet above sea level. The calibration of the fuselage vent system at sea level was in good agreement with the calibration in the flight manual, but the calibration at 25,000 feet differed from the values given in the flight manual by as much as 100 feet.

INTRODUCTION

A variety of experimental methods has been developed for the calibration of aircraft static-pressure systems. (See ref. 1.) Since the relative accuracy of these methods is not known, there is a need for the adoption of a standard method to which the calibrations by other methods could be referenced. In recognition of this need, the Federal Aviation Agency (FAA) requested the assistance of the National Aeronautics and Space Administration in investigating methods that might prove suitable as a national standard.

From a review of the currently known methods, it appeared that the ground-camera method (ref. 2) for calibrations at low altitude and the ground-radar method (ref. 3) for calibrations at high altitude will meet the characteristics of high accuracy and reproducibility (in terms of test equipment and experimental technique) demanded of a standard method.

To investigate the accuracy that could be achieved with these methods, the FAA and the NASA set up a test program in which the fuselage vent system of a high-subsonic transport could be calibrated by each of the two methods. For the calibration by the ground-camera technique, use was made of the same instrumentation that was used in the tests of reference 2. For the high-altitude calibration, however, the instrumentation of the present test program represented a considerable improvement over the test equipment used in the investigation of reference 3. The improved instrumentation included a recording statoscope (instead of a recording altimeter) for measuring the pressure of the static-pressure system and a precision radar (instead of a radar-phototheodolite) for measuring the geometric altitude of the airplane.

As a supplementary part of the test program, calibration data were also obtained for a static-pressure tube located forward of and above the pilot's compartment. This installation was investigated because it was thought that a tube located in this region might provide a static-pressure source with errors that would not vary too greatly with Mach number.

SYMBOLS

C_L	lift coefficient
D	diameter of airplane fuselage
E_c	elevation from sea level of camera test site, ft
E_r	reference elevation of ground position at which statoscope was sealed, ft
g	acceleration of gravity at camera station, ft/sec^2
ΔH	pressure-altitude error, equivalent to Δp, ft
h_1	height of wing tips above ground when airplane is at rest, ft
Δh_1	wing-tip deflection when airplane is in flight, ft
h_2	altitude of wing tips above camera, ft
h_3	height of camera above ground, ft
M	Mach number
p	calculated pressure at altitude $Z_r + \frac{Z_s - Z_r}{2}$, lb/sq ft

p_o	pressure in standard atmosphere at altitude $Z_r + \frac{Z_s - Z_r}{2}$, lb/sq ft
p_T	static pressure measured by pitot-static tube, lb/sq ft
p_t	total pressure measured by pitot-static tube, lb/sq ft
p_V	static pressure measured by fuselage vents, lb/sq ft
p_∞	free-stream static pressure, lb/sq ft
Δp	static-pressure error, lb/sq ft
Δp_c	calculated pressure difference between pressures at Z_r and Z_s, $-\rho g(Z_s - Z_r)$, lb/sq ft
Δp_m	measured pressure difference between Z_r and Z_s, lb/sq ft
$\Delta p_{m,p}$	measured pressure difference between Z_r and Z_p, lb/sq ft
$\Delta p'_{m,p}$	$\Delta p_{m,p}$ corrected for change in atmospheric pressure during time period of survey, lb/sq ft
$\Delta p''_{m,p}$	$\Delta p'_{m,p}$ corrected for static-pressure error, as determined by sea-level calibration, applicable to C_L of survey run, lb/sq ft
$\Delta p_m - \Delta p_c$	Δp for low-altitude method, lb/sq ft
$\Delta p_m - \Delta p''_{m,p}$	Δp for high-altitude method, lb/sq ft
$p_T - p_\infty$	Δp for pitot-static-tube installation, lb/sq ft
$p_V - p_\infty$	Δp for fuselage vent systems, lb/sq ft
q_c	impact pressure, $p_t - p_\infty$, lb/sq ft
T	calculated temperature at altitude $Z_r + \frac{Z_s - Z_r}{2}$, ^oF abs
T_o	temperature in standard atmosphere at altitude $Z_r + \frac{Z_s - Z_r}{2}$, ^oF abs
t_1	time of initial run of pressure-altitude survey before speed runs, minutes

t_2 time of initial run of pressure-altitude survey after speed runs, minutes

V_i indicated airspeed, knots

Z_p geometric altitude of airplane for pressure-altitude survey runs, ft

Z_r reference geometric altitude of airplane at which statoscope was sealed, ft

Z_s geometric altitude of airplane for speed runs, ft

ρ calculated air density at altitude $Z_r + \frac{Z_s - Z_r}{2}$, slugs/cu ft

ρ_o density in standard atmosphere at altitude $Z_r + \frac{Z_s - Z_r}{2}$, slugs/cu ft

σ standard deviation of test data

AIRPLANE AND TEST INSTRUMENTATION

Airplane

The airplane used for the static-pressure measuring program was a turbojet transport. (See fig. 1.) This airplane was equipped with two static-pressure installations: a fuselage vent system and a special test installation consisting of a pitot-static tube (type AN 5810) located above and forward of the pilot's compartment. The locations of the static-pressure sources of the two systems are shown in figure 2.

Test Instrumentation

Airborne instruments.- The instruments used to measure the pressures of the static-pressure systems included an airspeed-altitude recorder, a differential-pressure recorder, and a recording statoscope. (See fig. 3.) The statoscope is an instrument incorporating a sensitive differential-pressure gage that measures the pressure of the static-pressure system with respect to the pressure in a thermostatically controlled chamber that can be sealed at any altitude.

The statoscope, altimeter, and static-pressure port of the airspeed capsule were connected to the copilot's fuselage vent system. The pitot port of the airspeed capsule was connected to the total-pressure tube of the special pitot-static tube installation. The differential-pressure recorder was connected between the static-pressure tube of the special test installation and the copilot's fuselage vent system.

The records of all of the instruments were marked with an identical time scale. A record synchronizer applied a mark along the recorded time scale whenever the synchronizer was actuated by an observer in the airplane.

The ranges and sensitivities of the pressure recorders were as follows:

Instrument	Range, lb/sq ft	Sensitivity, lb/sq ft/in. record trace deflection
Airspeed recorder	800	Variable from 95 at 150 knots to 115 at 370 knots
Altitude recorder	2,200	Variable from 295 at sea-level to 200 at 25,000 ft
Differential-pressure recorder	±52	49
Recording statoscope	165	32

In order that the precision of the radar tracking be increased, a radar transponder (fig. 4(a)) was installed in the airplane with the antenna located on the under side of the fuselage-nose section (fig. 4(b)).

Ground-based equipment.- The ground-based equipment for the low-altitude method consisted of a 5- by 5-inch single-exposure camera, a radio transmitter-receiver, a thermometer, and a precision altimeter (Air Force type MA-1), which was especially selected for low hysteresis and repeatability at pressures near sea level. (See fig. 5.) The camera was mounted with its optical axis alined with the vertical and was equipped with a sighting device that enabled the camera operator to determine when the airplane was directly overhead. The radio was used by the camera operator to transmit a voice signal at the instant he actuated the camera; an observer in the airplane actuated the record synchronizer at the instant he received the signal, thereby synchronizing the instrument records with the camera photograph. Readings of the thermometer and altimeter provided measures of air temperature and barometric pressure which were used to compute the density of the air.

The ground-based equipment for the high-altitude method consisted of a tracking radar set, the AN/FPS-16. (See fig. 6.) This radar provided measures of elevation angle and slant range from which the geometric altitude of the airplane could be computed. The values of elevation angle and slant range were recorded on magnetic tape at intervals of 0.1 second. The radar was also used to vector the airplane into the test area for both the pressure-altitude survey runs and for the speed runs. For each of the test runs, the airborne-instrument records and the radar tape were synchronized by means of a radio voice signal from the radar control center; on hearing the signal, the airplane observer actuated the record synchronizer and the radar operator actuated the tape marker.

EXPERIMENTAL METHODS AND TEST PROGRAMS

Experimental Methods

Low-altitude method.- The test procedure for the calibration of static-pressure systems at low altitude (i.e., near ground level) requires that the airplane be flown at constant speed and altitude over a ground-based camera. Prior to flight, the statoscope is sealed with the airplane at rest on the ground at a known elevation. The airplane is then flown successively over the camera at the test speeds for which calibration data are required.

When the airplane is over the camera, the pressure recorded by the statoscope is a measure of (1) the pressure difference between the flight level and the ground position at which the statoscope was sealed and (2) the error of the static-pressure system. The pressure difference between flight level and ground elevation is computed from the geometric altitude of the airplane as determined from the camera photographs and from the value of the existing air density as determined from the measured temperature and pressure at the camera station. The static-pressure error is then determined as the difference between the measured and computed pressure differentials between the ground elevation and the flight level.

High-altitude method.- For the calibration of static-pressure systems at high altitude, the existing variation of atmospheric pressure with height is first determined through a limited range of altitude within a preselected test area. Just prior to the pressure-altitude survey, the statoscope is sealed at some altitude near the lower limit of the test altitude range. The variation of pressure with altitude is then determined by flying the airplane through the test altitude range at a low airspeed, for which the static-pressure error had been determined by the low-altitude method. During the pressure-altitude survey (and for the subsequent speed runs as well) the height of the airplane is measured by a ground-based radar and the pressure is measured with reference to the pressure at the altitude at which the statoscope was sealed.

Immediately following the pressure-altitude survey, the airplane is flown through the test area near the midpoint of the surveyed altitude range at the test airspeeds for which static-pressure errors are to be determined. At the completion of the speed runs, a second pressure-altitude survey is conducted to determine any variation of atmospheric pressure during the time period of the tests.

For each speed run, the static-pressure error is determined as the difference between the pressure differential measured during the speed run and the corresponding pressure differential in the atmosphere. The pressure differential in the atmosphere is determined from the two pressure-altitude surveys (corrected for the static-pressure error corresponding to the survey speed) and from the height and time at which the calibration run was conducted.

Test Programs

Low-altitude tests.- The test program for the low-altitude calibration consisted of a series of speed runs at an altitude of about 600 feet over the camera station. For the first of two flights the indicated airspeeds and flap settings were as follows:

Indicated airspeed, knots	Flap setting, deg
150	20
200	0
260	0
320	0

The tests were conducted in sequence from low speed to high speed, and the sequence was repeated three times. For the second flight, which was made the day after the first flight, the test program for airspeeds of 200 and 320 knots was repeated. During the first flight, the aircraft weight varied from 150,000 to 128,000 pounds; for the second flight, the weight varied from 153,000 to 140,000 pounds.

High-altitude tests.- The calibrations of the static-pressure systems at high altitude were determined during two flights conducted on successive days. Each flight was conducted within a test area having a diameter of about 10 miles; the center of the area was located about 12 miles from the radar. At the start of the flight the statoscope was sealed at an altitude of about 24,000 feet. A pressure-altitude survey was then conducted at an indicated airspeed of 200 knots and flap setting of 0° at nominal altitudes of 24,000, 25,000, and 26,000 feet. At each altitude, six survey runs were made with the airplane stabilized in speed and altitude. For each survey run the airplane was on a different heading and in a different region of the test area; hence, the slant range, elevation angle, and pressure measurement were different for each test run. This test procedure provided independent measures of altitude and pressure differential for the six survey runs.

Following the initial pressure-altitude survey, speed runs were made through the test area at an altitude of about 25,000 feet and at indicated airspeeds of 235, 320, and 370 knots. The sequence of the tests was from low to high speed and was repeated three times. Immediately following the last speed run, a second pressure-altitude survey was conducted at the speed and altitudes of the initial survey. During all these survey and speed runs the airplane was tracked with the airborne transponder in operation.

At the completion of the second pressure-altitude survey of the first flight, the survey at 26,000 feet was repeated with six runs at an indicated airspeed of 150 knots and a flap setting of 20°. During the test period of the first flight the aircraft weight varied from 154,000 to 130,000 pounds, and for the second flight the weight varied from 150,000 to 132,000 pounds.

DATA REDUCTION

Low-Altitude Method

In the low-altitude method, the difference between the pressure at the reference geometric altitude of the airplane Z_r and the pressure at the geometric altitude of the airplane over the camera station Z_s was calculated from the relation

$$\Delta p_c = -\rho g(Z_s - Z_r)$$

where ρ is the air density at the midpoint between Z_r and Z_s, and g is the acceleration of gravity at the camera station. The value of ρ at altitude $Z_r + \frac{Z_s - Z_r}{2}$ was computed from the equation

$$\rho = \rho_o \frac{p}{p_o} \frac{T_o}{T}$$

where p and T are calculated values of the existing pressure and temperature at altitude $Z_r + \frac{Z_s - Z_r}{2}$, and ρ_o, p_o, and T_o are the density, pressure, and temperature, respectively, in the standard atmosphere at the same altitude. The values of p and T were computed from the measured values of pressure and temperature at the camera station and on the assumption of a standard pressure and temperature gradient with altitude.

For the determination of the value of $Z_s - Z_r$ in the low-altitude method, the wing tips of the airplane were used as a reference for the altitude measurements. The altitude h_2 of the wing tips above the camera was computed from the wing span of the airplane, the length of the wing span on the photographic film, and the focal length of the camera lens. As indicated in figure 7, the value of Z_s was then determined from the elevation of the camera site E_c, the height of the camera above the ground h_3, the value of h_2, and the deflection of the wing tips Δh_1 (about 3 feet for the test airplane). The reference altitude Z_r was determined from the elevation E_r of the ground position at which the statoscope was sealed and from the height h_1 of the wing tips above the ground when the airplane was at rest.

The measured pressure difference Δp_m between Z_r and Z_s was determined from the recording of the statoscope when the airplane was over the camera station. The recorded value of Δp_m for each speed run was corrected for any changes in barometric pressure that occurred after the statoscope was sealed. These changes in barometric pressure were determined from the readings of the precision altimeter at the camera station. The static-pressure error Δp was then determined as the difference between the corrected values of Δp_m and the calculated pressure increment Δp_c.

The film records from the pressure recorders and from the camera were evaluated with either a precision scale or an optical measuring instrument having a higher order of reading accuracy. The records of the airspeed recorder and the recording altimeter were evaluated with the scale to a reading accuracy of 0.01-inch film-trace deflection. The values of q_c determined from the air-speed recorder were used for the computation of C_L; the values of p_V determined from the recording altimeter were used, in combination with the values of q_c, for the determination of M. The records of the differential-pressure recorder and the recording statoscope were evaluated to an accuracy of 0.002-inch trace deflection. This measuring accuracy corresponded to a reading accuracy of 0.1 pound per square foot for the differential-pressure recorder and 0.06 pound per square foot for the statoscope. The photographs of the airplane were read to an accuracy of 0.002 inch; for the smallest wing-span image lengths recorded (about 1.5 inches), this reading accuracy corresponded to an error in altitude of about 1 foot.

High-Altitude Method

The application of the pressure-altitude survey to the determination of static-pressure errors by the high-altitude method is illustrated in figure 8. The two solid lines in this figure represent the pressure differential $\Delta p_{m,p}$ from altitude Z_r (the altitude at which the statoscope was sealed) to the altitudes Z_p of the survey test runs. The difference between the values of $\Delta p_{m,p}$ at the various values of Z_p in the surveys before and after the speed runs represent the change in atmospheric pressure during the test period. Because of this change in atmospheric pressure with time, it is necessary to adjust the $\Delta p_{m,p},Z_p$ curves to the times t_1 and t_2 of the initial survey run in each of the two surveys. This adjustment, which produces the $\Delta p'_{m,p},Z_p$ curves, is determined from (1) the change of $\Delta p_{m,p}$ with time at a given altitude Z_p and (2) the times at which the two values of $\Delta p_{m,p}$ were recorded. The $\Delta p'_{m,p},Z_p$ curves are then corrected for the error of the static-pressure system to produce the $\Delta p''_{m,p},Z_p$ curves, which represent the actual variation of atmospheric pressure with altitude at times t_1 and t_2. The static-pressure corrections are determined from the static-pressure errors measured by the low-altitude method at the same values of C_L.

For each speed run a value of $\Delta p''_{m,p}$ is determined from the altitude of the speed run Z_s and from interpolation between the two $\Delta p''_{m,p},Z_p$ curves on the basis of the time at which the speed run was recorded. In the illustrative figure 8, the speed run is assumed to have occurred at time $t_1 + \frac{t_1 + t_2}{2}$ so that the value of $\Delta p''_{m,p}$ representative of the atmospheric pressure at that time is the value midway between the two $\Delta p_{m,p},Z_p$ curves. The static-pressure error for the speed run is then determined as the difference between this value and the value $\Delta p''_{m,p}$ measured in the speed run.

For the high-altitude calibrations, the film records from the four pressure recorders were evaluated to the same reading accuracy as was employed for the low-altitude calibrations. The slant range and elevation angle measured by the radar were recorded in increments of 1 foot and 0.0001°, respectively; the altitude of the airplane was computed from these values to increments of 1 foot.

RESULTS AND DISCUSSION

Calibration of Fuselage Vent System

Low-altitude calibration.- The calibration of the fuselage vent system as determined by the low-altitude method is presented in figure 9. Calibration data were determined for flap settings of 0° and 20° and were obtained from two flights conducted on different days. The static-pressure errors Δp are presented as fractions of the impact pressures q_c and are plotted as a function of lift coefficient C_L. From the deviations of the data points from the faired curves, the standard deviation σ was found to be 0.3 pound per square foot or 4 feet at sea level. The maximum probable error (that is, the 3σ value or the value having a probability of 99.7 percent) is, therefore, about 1 pound per square foot or 12 feet at sea level.

Pressure-altitude surveys.- The pressure-altitude surveys determined in the first of the two high-altitude calibrations are presented in figure 10. This figure shows the variation with altitude Z_p of the measured pressure increment Δp_m of each survey run as determined at an indicated airspeed of 200 knots. Each of the data points was corrected for the atmospheric-pressure variation with time and for the static-pressure error for the lift coefficient of the test run. For both of the surveys, the maximum deviation of the data points from the faired curves was less than 0.5 pound per square foot or 15 feet at 25,000 feet above sea level.

Figure 11 shows a comparison of the pressure-altitude surveys determined at two airspeeds for which the static-pressure errors were different. (Note that the scales for both $\Delta p''_{m,p}$ and Z_p in figure 11 are expanded considerably with respect to those in figure 10.) For the indicated airspeed of 150 knots, the static-pressure error was essentially zero, whereas, for the airspeed of 200 knots, the error was about 1 pound per square foot. Despite this relatively large difference in the two errors, the data points for both survey airspeeds fall along a single curve with a maximum deviation no greater than 0.3 pound per square foot or 10 feet at 25,000 feet above sea level.

High-altitude calibration.- The calibration of the fuselage vent system at an altitude of about 25,000 feet is given in figure 12(a). This figure shows the variation of $\Delta p/q_c$ with C_L as determined at test airspeeds of 200, 235, 320, and 370 knots. The data for the 200-knot speed were determined from the pressure-altitude survey at 150 knots (fig. 11). A comparison of the sea-level calibration (from fig. 9) with the high-altitude data shows that the calibrations are the same at the higher values of C_L but that they deviate for values of C_L less than 0.3. At C_L less than 0.16 the errors for 25,000 feet became more positive because of compressibility effects. The standard deviation of the high-altitude data is 0.34 pound per square foot, so that the maximum probable error is about 1 pound per square foot; the corresponding altitude error for 25,000 feet is 30 feet.

In figure 12(b) values of $\Delta p/q_c$ for both sea level and 25,000 feet are plotted as functions of Mach number. Also shown in this figure is the sea-level curve extrapolated to 25,000 feet on the assumption that the static-pressure error is a function of C_L only. This extrapolated curve agrees with the experimental curve to within 0.2-percent q_c for the Mach number range up to 0.77. Since this is the Mach number at which the error of this fuselage vent installation begins to rise, it is also the limiting Mach number to which the extrapolated sea-level data could be expected to agree with the 25,000-foot curve.

Figure 13 shows the variation with indicated airspeed of the altitude error ΔH of the fuselage vent system at sea level and for an altitude of 25,000 feet. The values of ΔH were determined from the values of $\Delta p/q_c$ from figure 12(b) and were computed on the basis of the pressure-altitude gradients of the standard atmosphere. Also shown in figure 13 are the calibrations given in the flight manual of the airplane. Although the two sea-level curves agree to within 10 feet, the 25,000-foot curves differ by as much as 100 feet at the higher speeds; in addition, the reversal point of the curve determined in the present tests occurs at an indicated airspeed about 20 knots lower than that of the flight-manual curve.

Calibration of pitot-static-tube installation.- The calibration of the pitot-static-tube installation was determined indirectly from the calibration of the fuselage vent system and from the measured pressure difference between the tube and the vents. This pressure difference $p_T - p_V$ is presented in figure 14 as a fraction of q_c and is plotted as a function of C_L; data are given for both sea level and an altitude of 25,000 feet. The calibration of the tube installation as a function of C_L (fig. 15) was determined from the values of $\frac{p_T - p_V}{q_c}$ in figure 14 and from the values of $\Delta p/q_c$ of the fuselage vent systems in figures 9 and 12(a). In figure 16 the calibrations of the tube installation are presented as a function of Mach number. As indicated by these calibrations, the static-pressure errors of the tube installation range from about $7\frac{1}{2}$ to $13\frac{1}{2}$ percent of q_c. Because of the magnitude of these errors and the fact that the errors for both sea level and 25,000 feet vary considerably with Mach number, it would appear that the tube location tested in this investigation would prove unsatisfactory for the measurement of static pressure.

CONCLUSIONS

Calibrations of two static-pressure systems on a large turbojet transport were determined near sea level by a ground-camera technique and at an altitude of 25,000 feet by a ground-radar method. The two static-pressure systems were a fuselage vent system and a boom-mounted pitot-static-tube installation located above and forward of the pilot's compartment. The results of the tests indicated that:

1. The maximum probable error (3 standard deviations) of both the low- and the high-altitude calibrations of the fuselage vent system was about 1 pound per square foot with corresponding altitude errors of 12 feet at sea level and 30 feet at 25,000 feet above sea level.

2. The calibration of the fuselage vent system at sea level was in good agreement with the calibration in the flight manual, but the calibration at 25,000 feet differed from the values given in the flight manual by as much as 100 feet.

3. The calibration of the pitot-static tube showed that the position of the tube of this installation was unsatisfactory for the measurement of static pressure because the errors at both sea level and 25,000 feet were large, and because the variation of the error with Mach number was also large.

Langley Research Center,
National Aeronautics and Space Administration,
Langley Station, Hampton, Va., July 15, 1963.

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3. Zalovcik, John A.: A Radar Method of Calibrating Airspeed Installations on Airplanes in Maneuvers at High Altitudes and at Transonic and Supersonic Speeds. NACA Rep. 985, 1950.

Figure 1.- Turbojet transport used for the calibration of two static-pressure systems. L-63-505

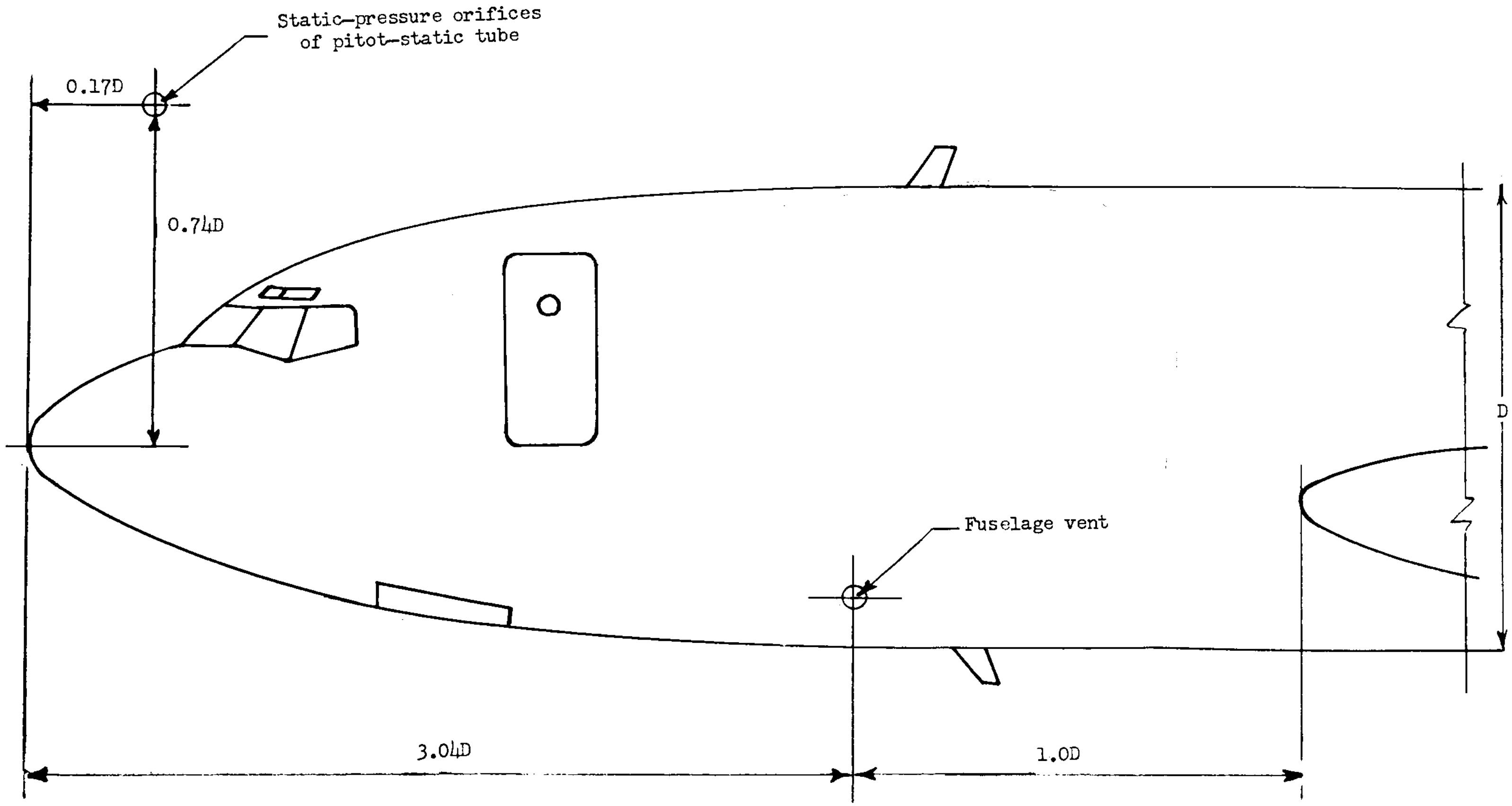
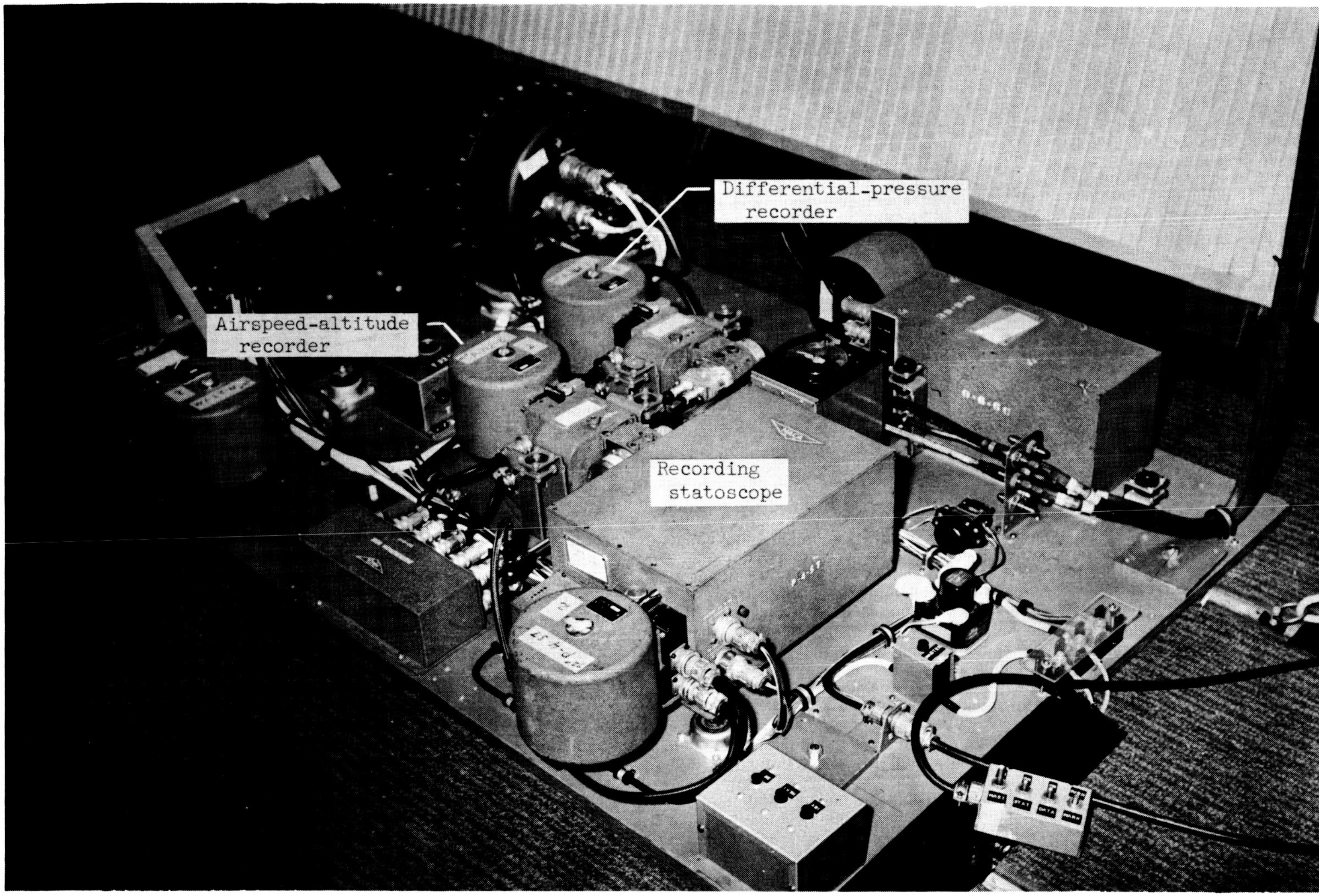
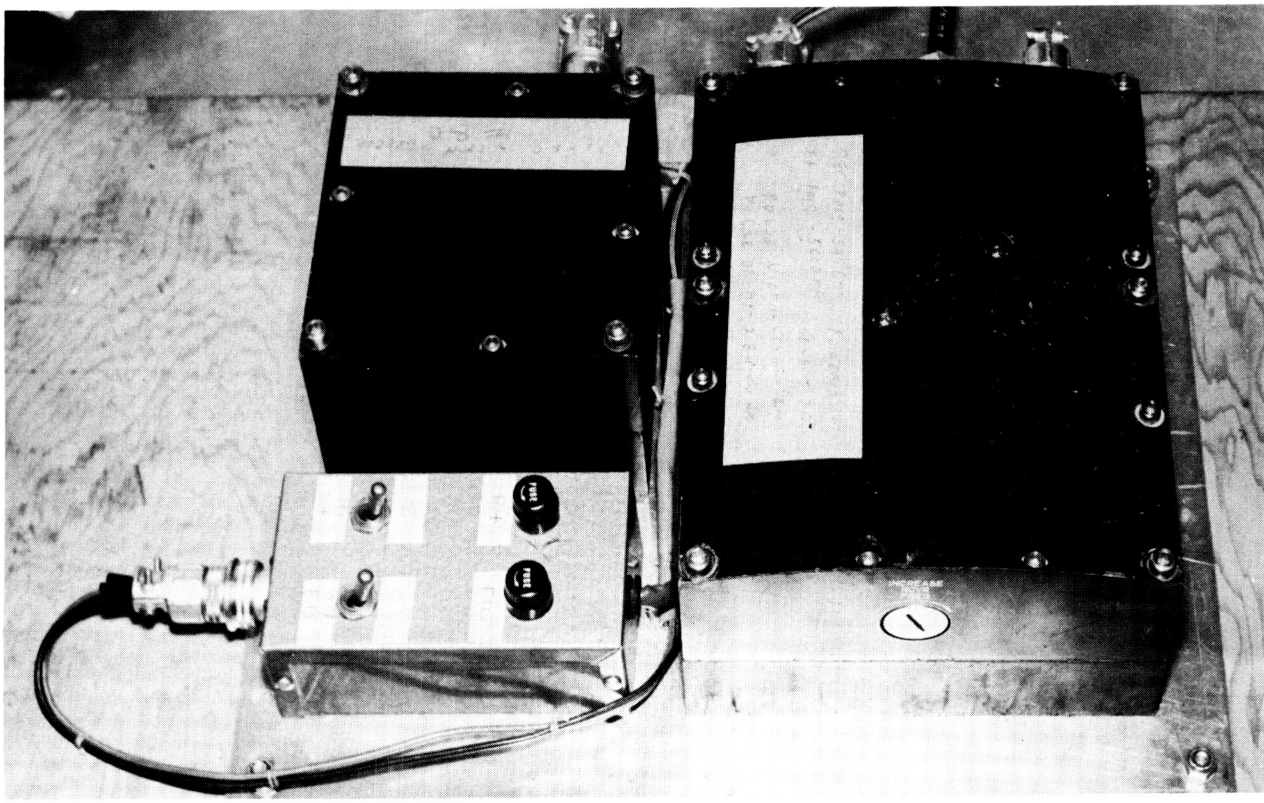


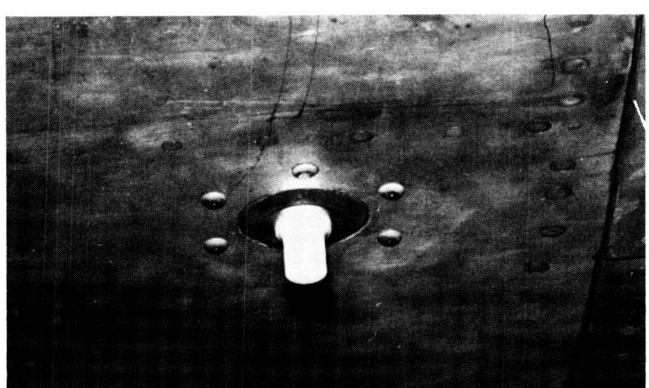
Figure 2.- Diagram showing location of fuselage vent and static-pressure orifices of pitot-static tube.



L-63-509.1
Figure 3.- Pressure recording instruments used for calibration of two static-pressure systems.



(a) Transponder. L-63-508



L-63-510
(b) Antenna on under side of fuselage-nose section.

Figure 4.- Radar transponder and antenna.

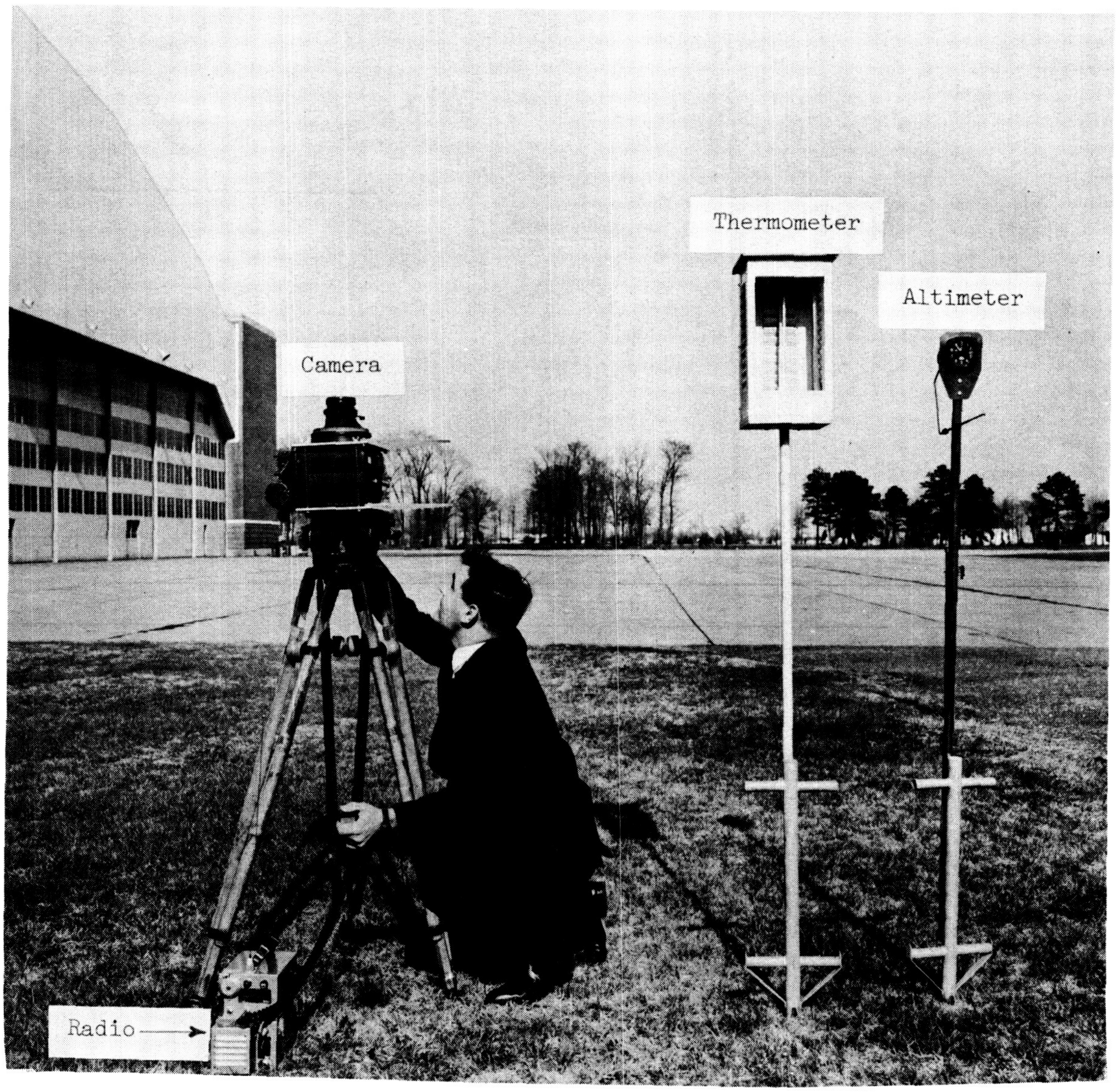


Figure 5.- Ground-based equipment used in low-altitude-calibration method. L-62-1489.1

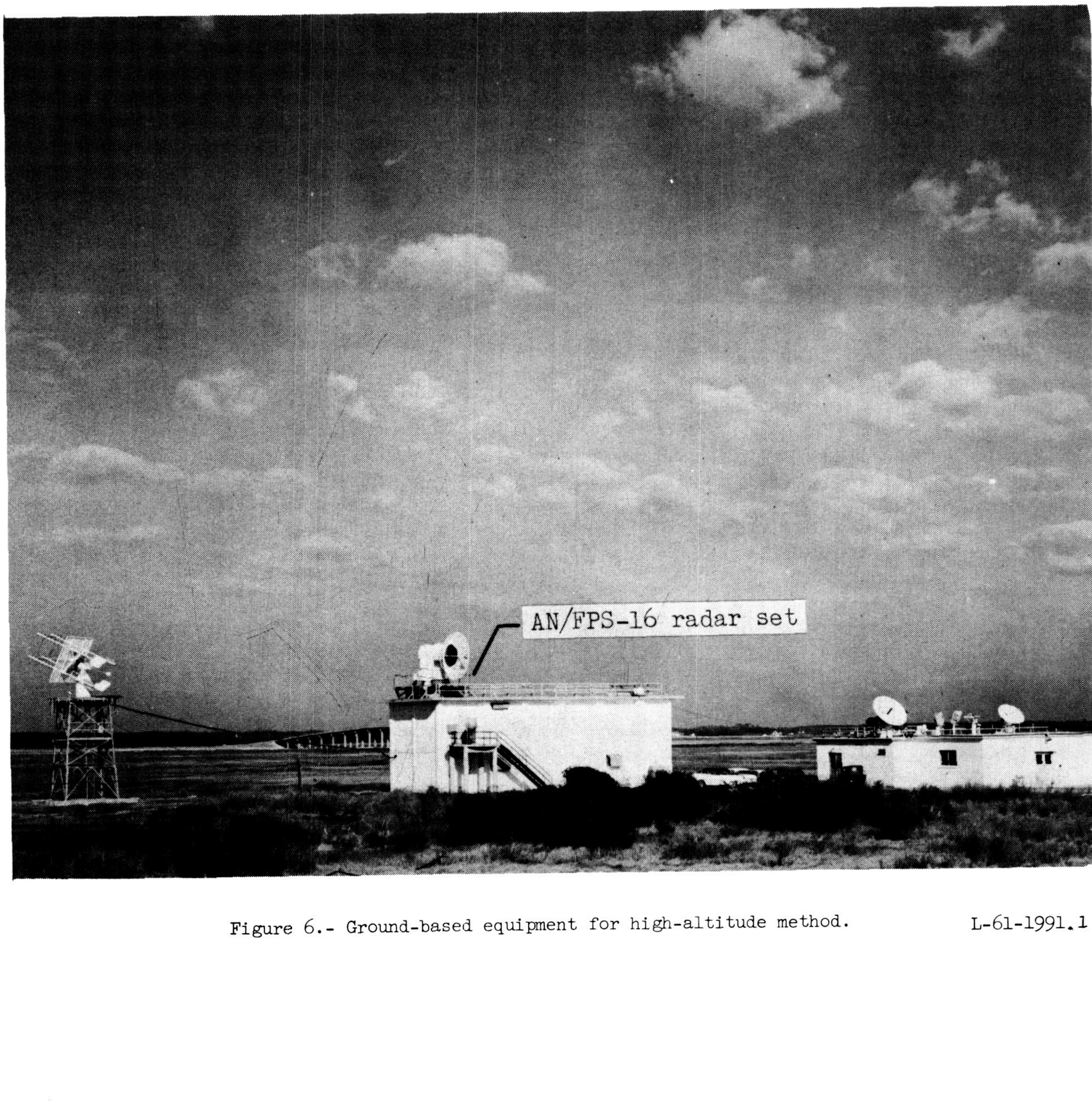


Figure 6.- Ground-based equipment for high-altitude method. L-61-1991.1

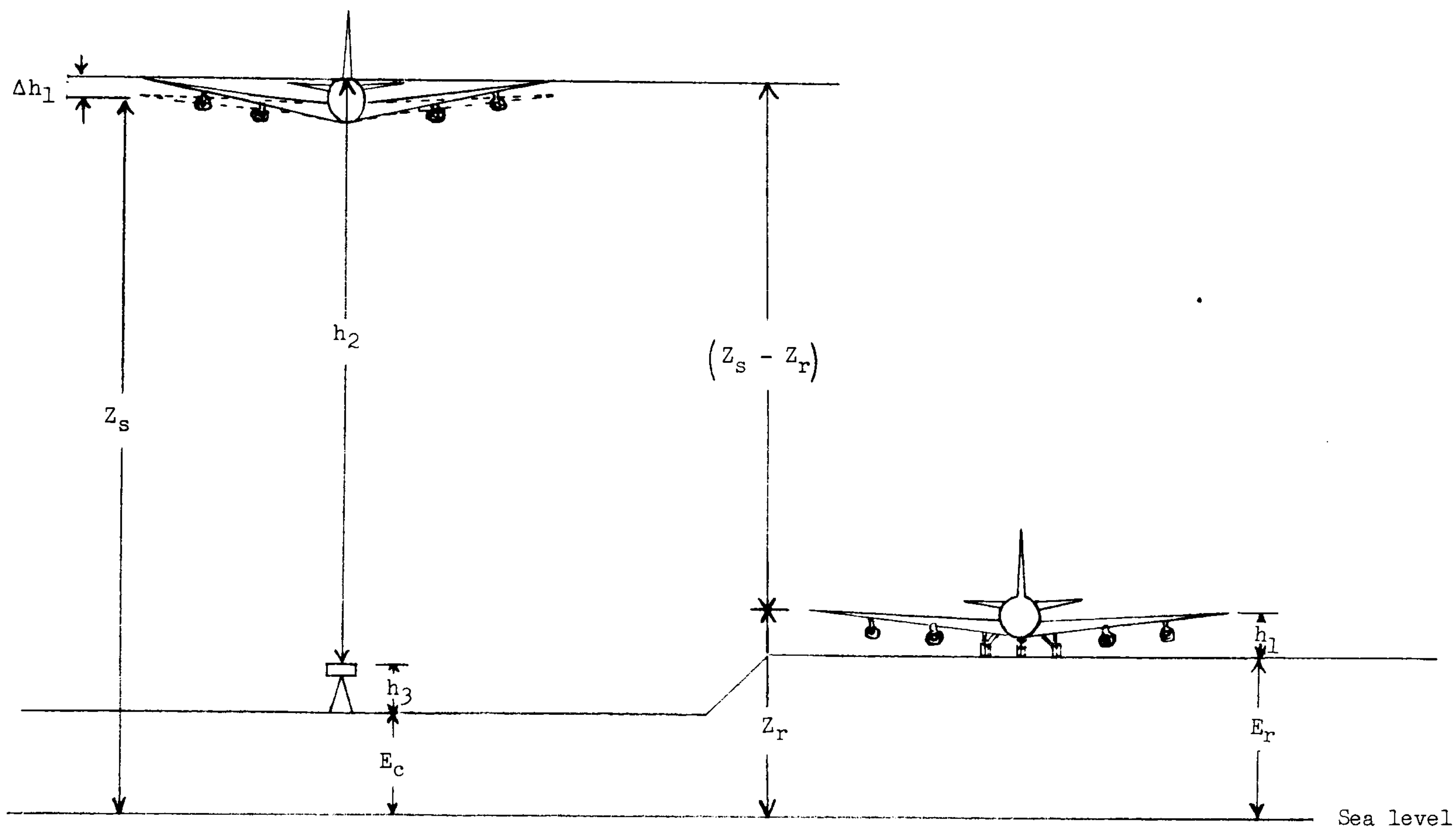


Figure 7.- Diagram showing dimensions required for determining Z_s-Z_r for low-altitude method.

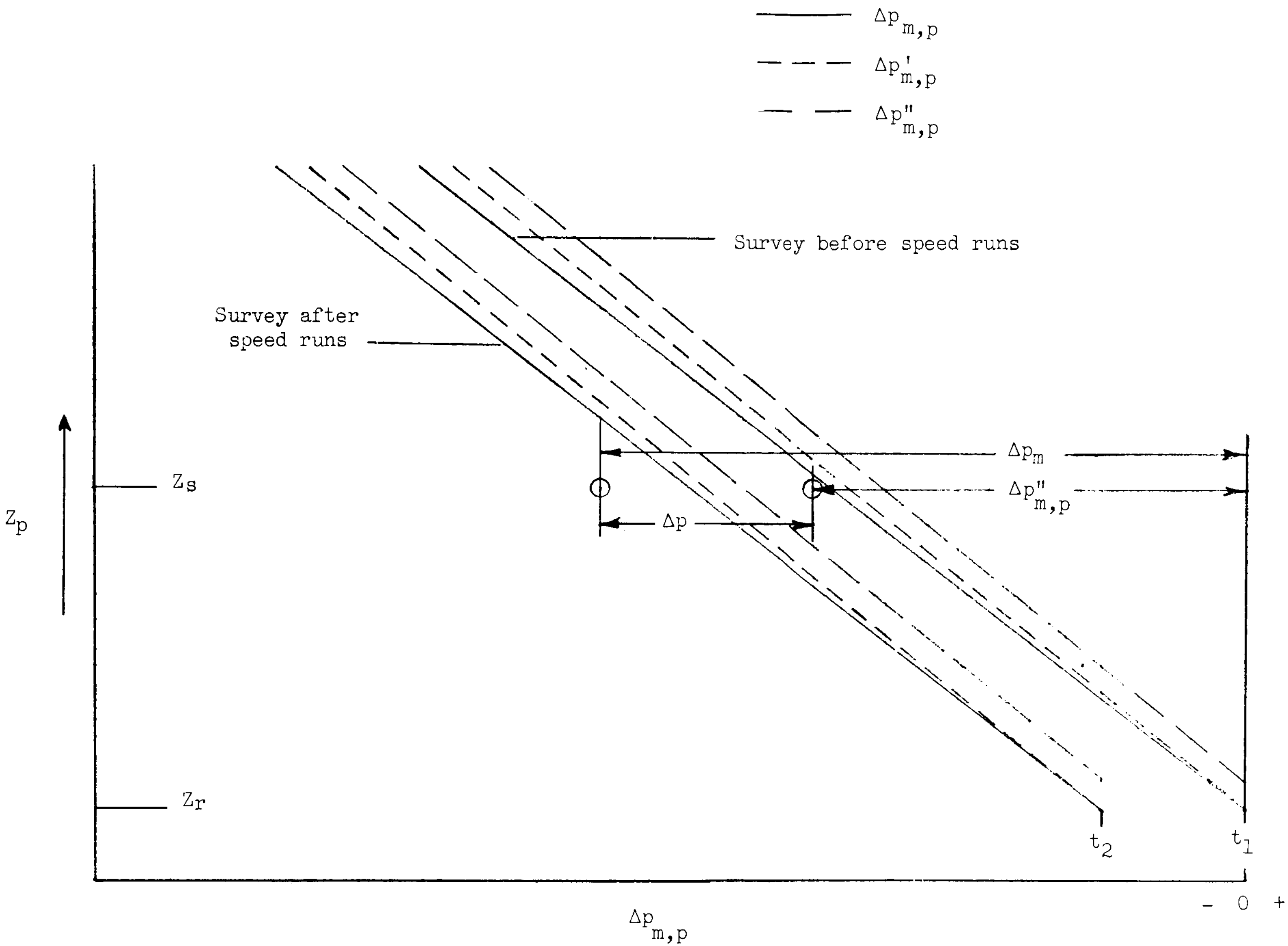


Figure 8.- Diagram of pressure-altitude survey illustrating method of determining Δp from Δp_m measured during speed run and $\Delta p''_{m,p}$ determined from $\Delta p_{m,p}, Z_p$ survey.

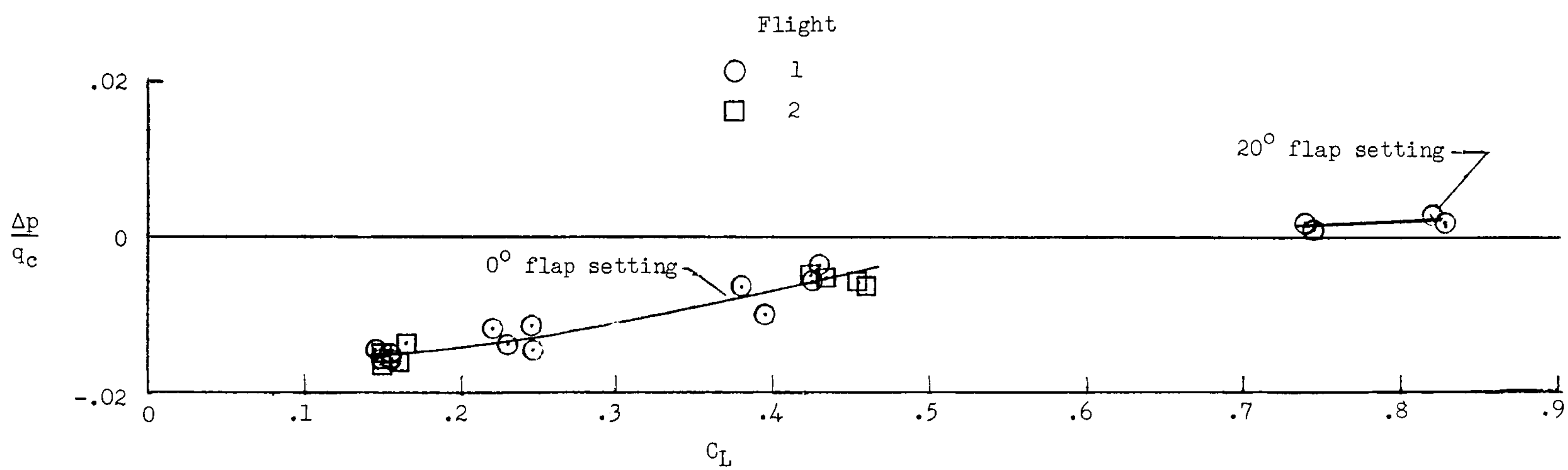


Figure 9.- Calibration of fuselage vent system by low-altitude method.

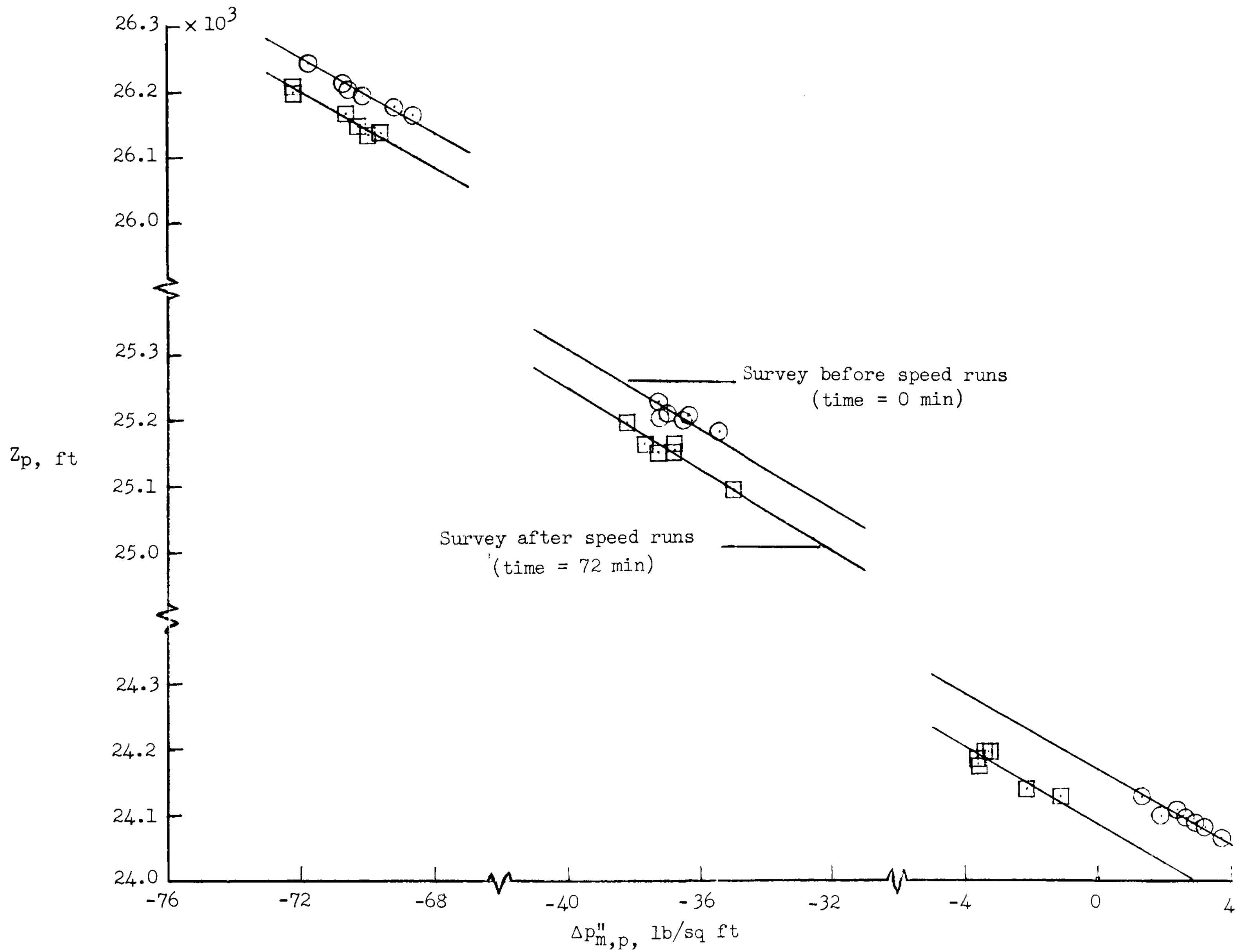


Figure 10.- Pressure-altitude survey established during one of two high-altitude flights at indicated airspeed of 200 knots.

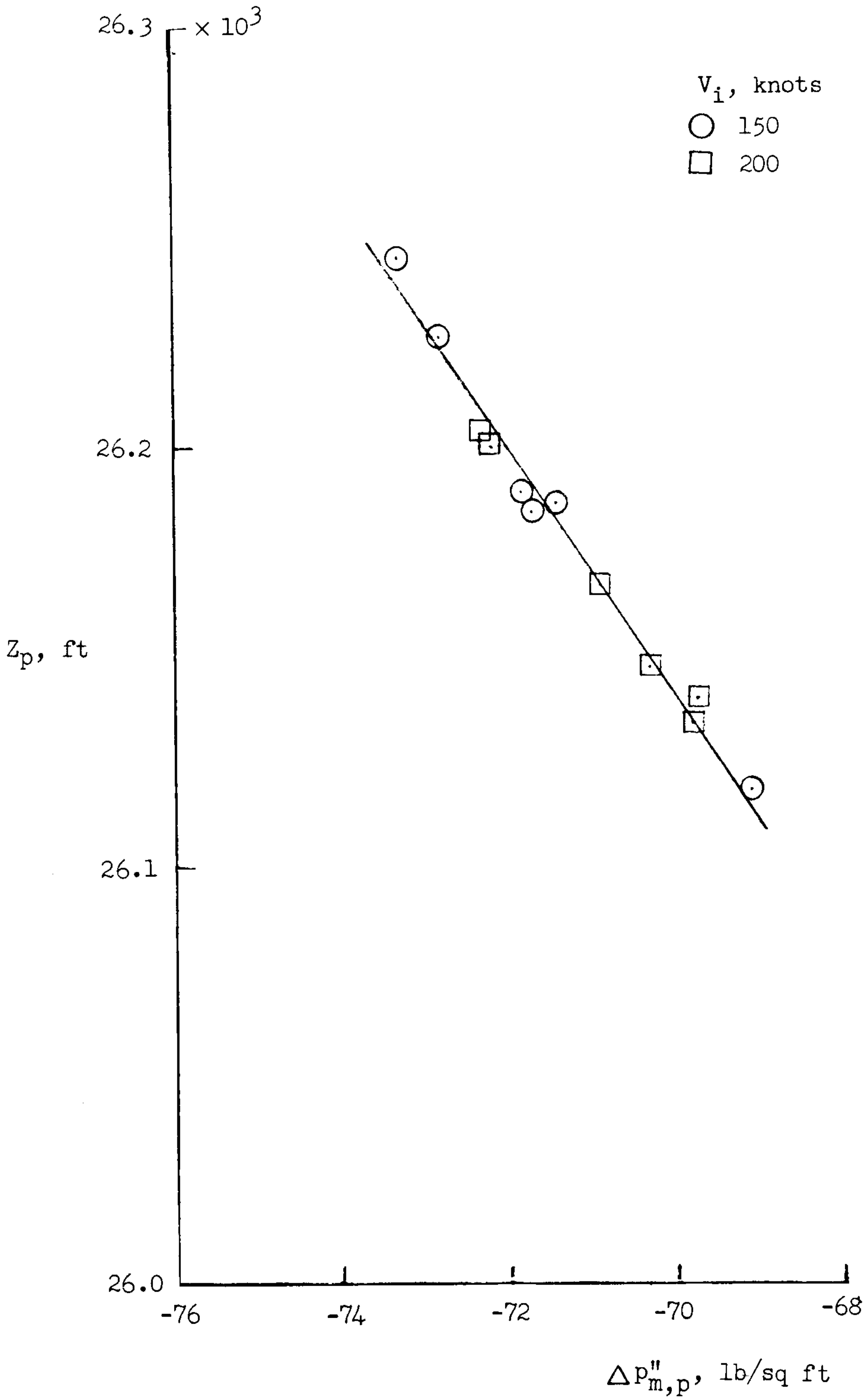
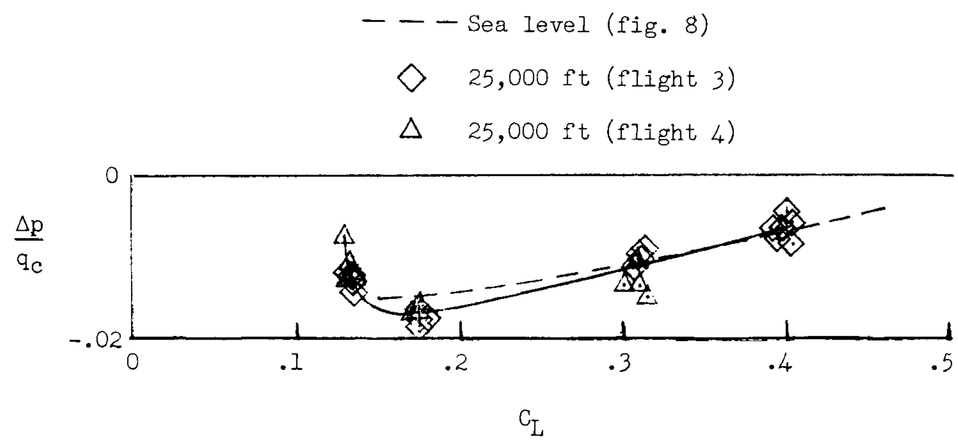
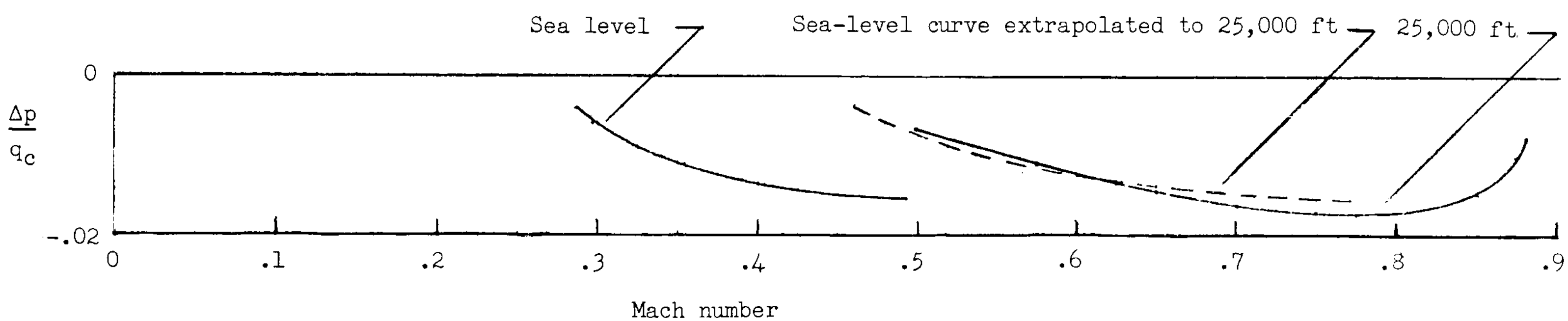


Figure 11.- Pressure-altitude survey at two indicated airspeeds.



(a) Variation of static-pressure error with lift coefficient.



(b) Variation of static-pressure error with Mach number for an aircraft weight of 140,000 pounds.

Figure 12.- Calibration of fuselage vent system at sea level and at 25,000 feet.

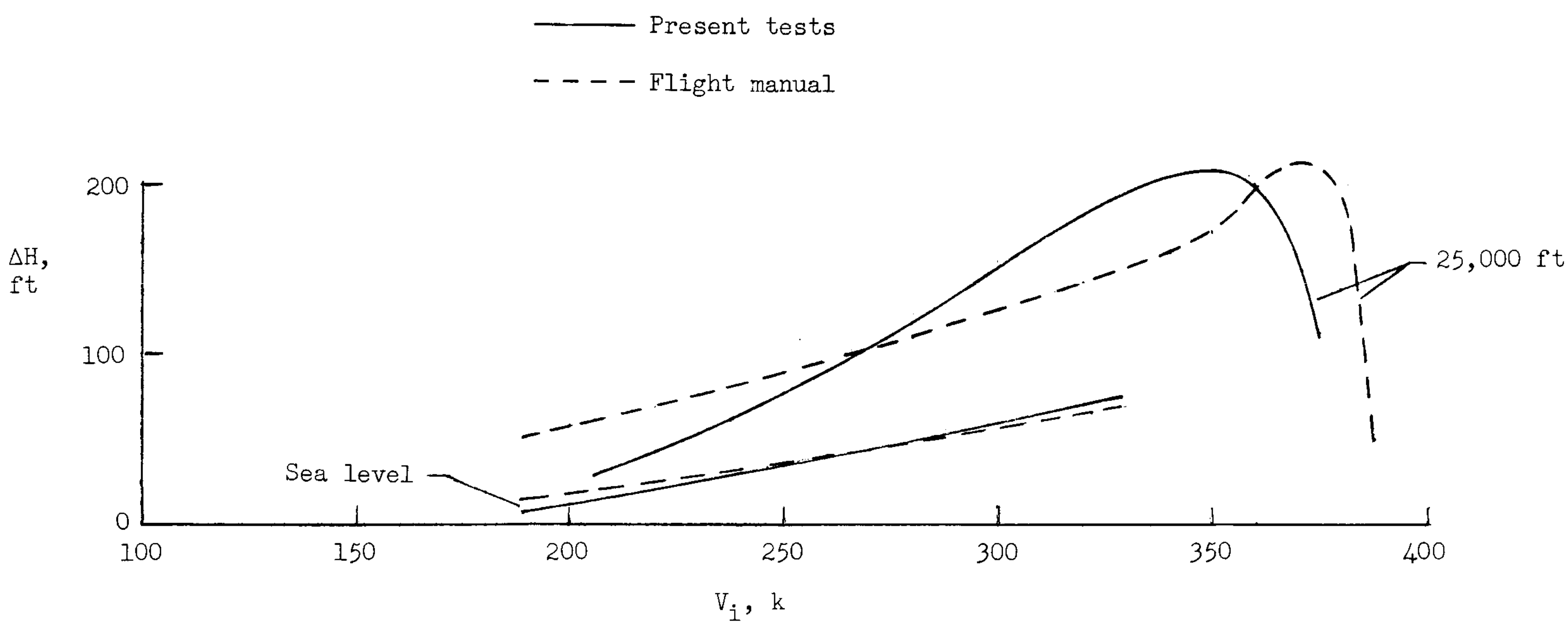


Figure 13.- Variation of altitude error of fuselage vent system with indicated airspeed.

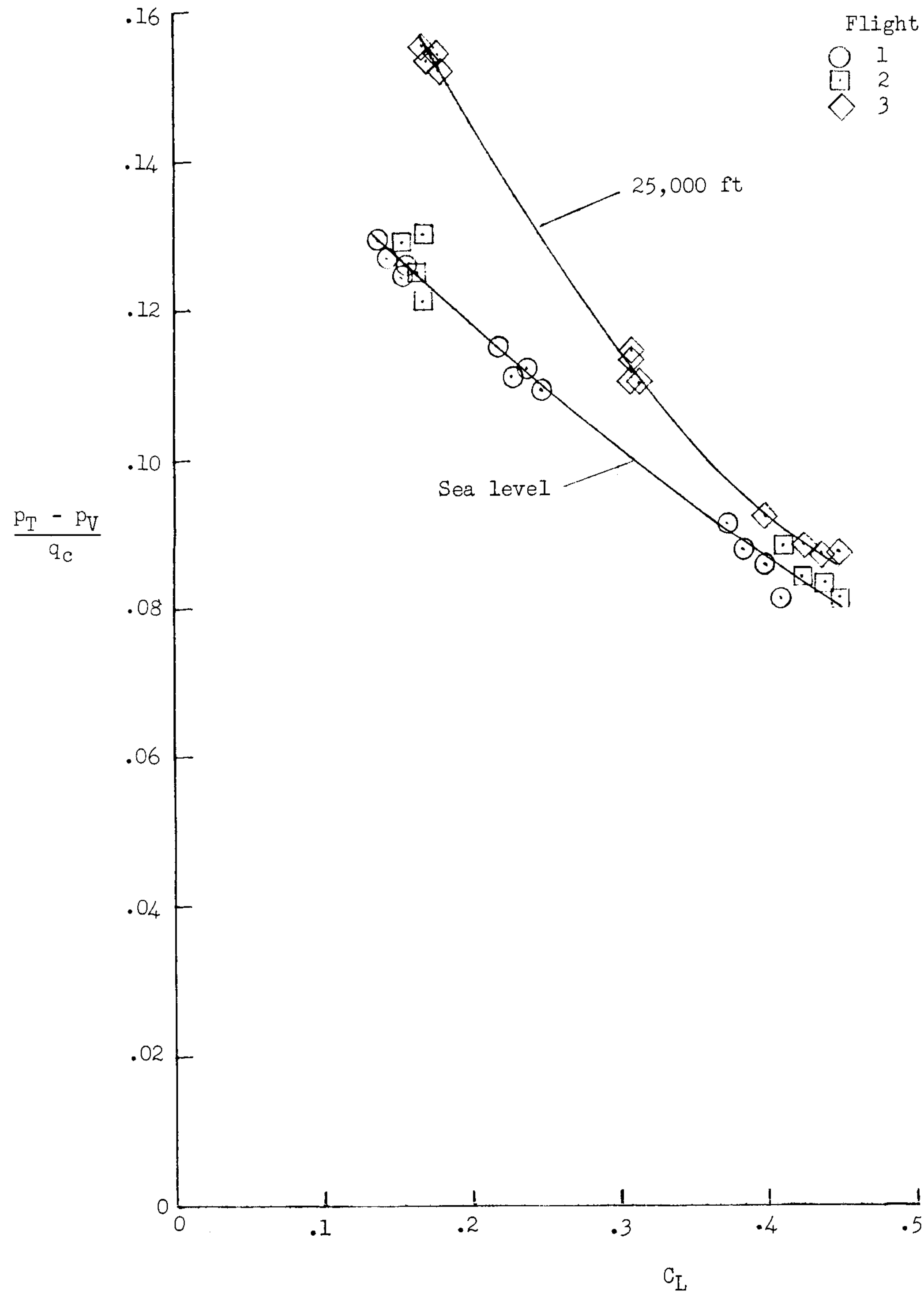


Figure 14.- Variation with lift coefficient of difference between static pressure measured by pitot-static tube and by fuselage vent system.

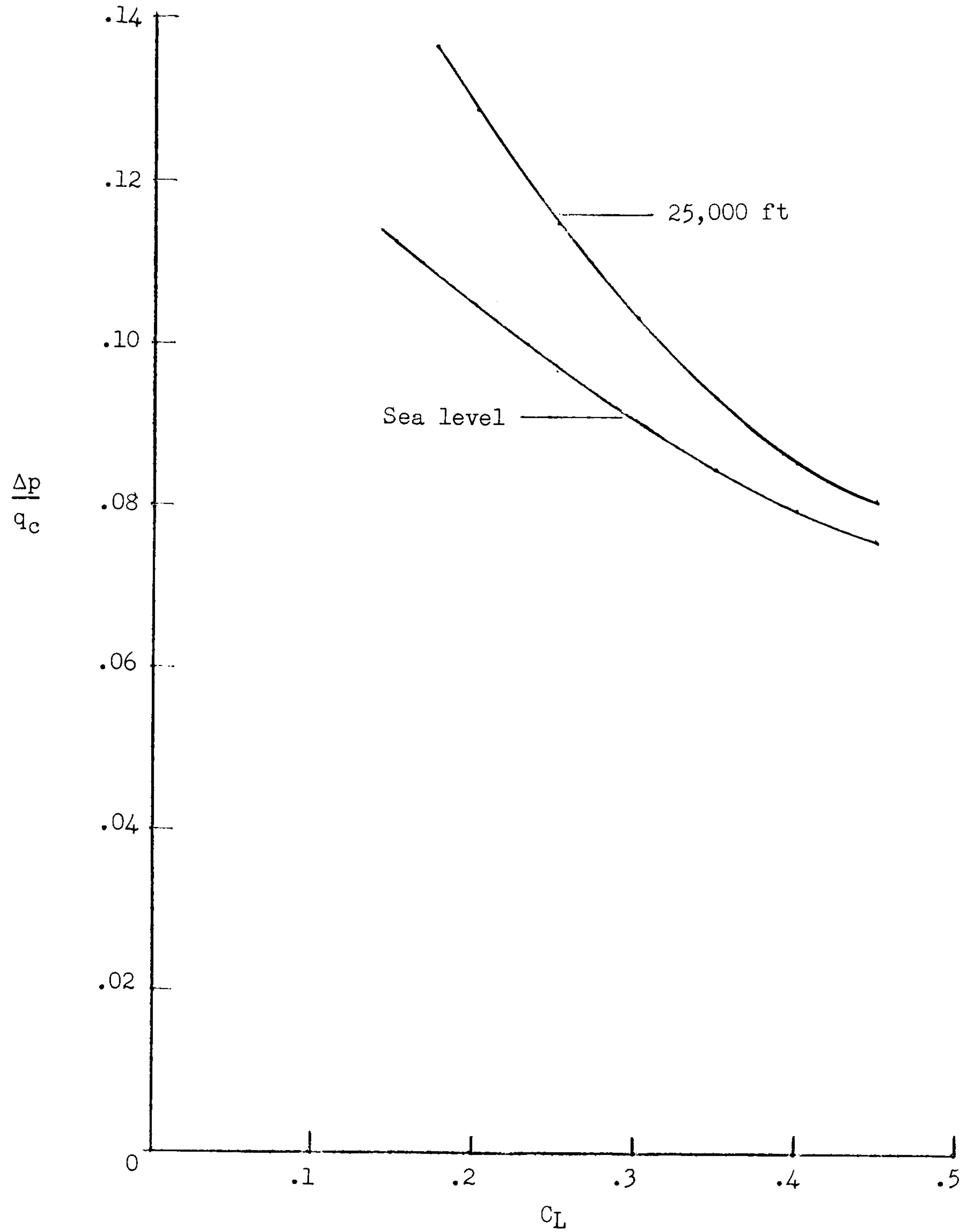


Figure 15.- Variation with lift coefficient of static-pressure error of pitot-static tube.

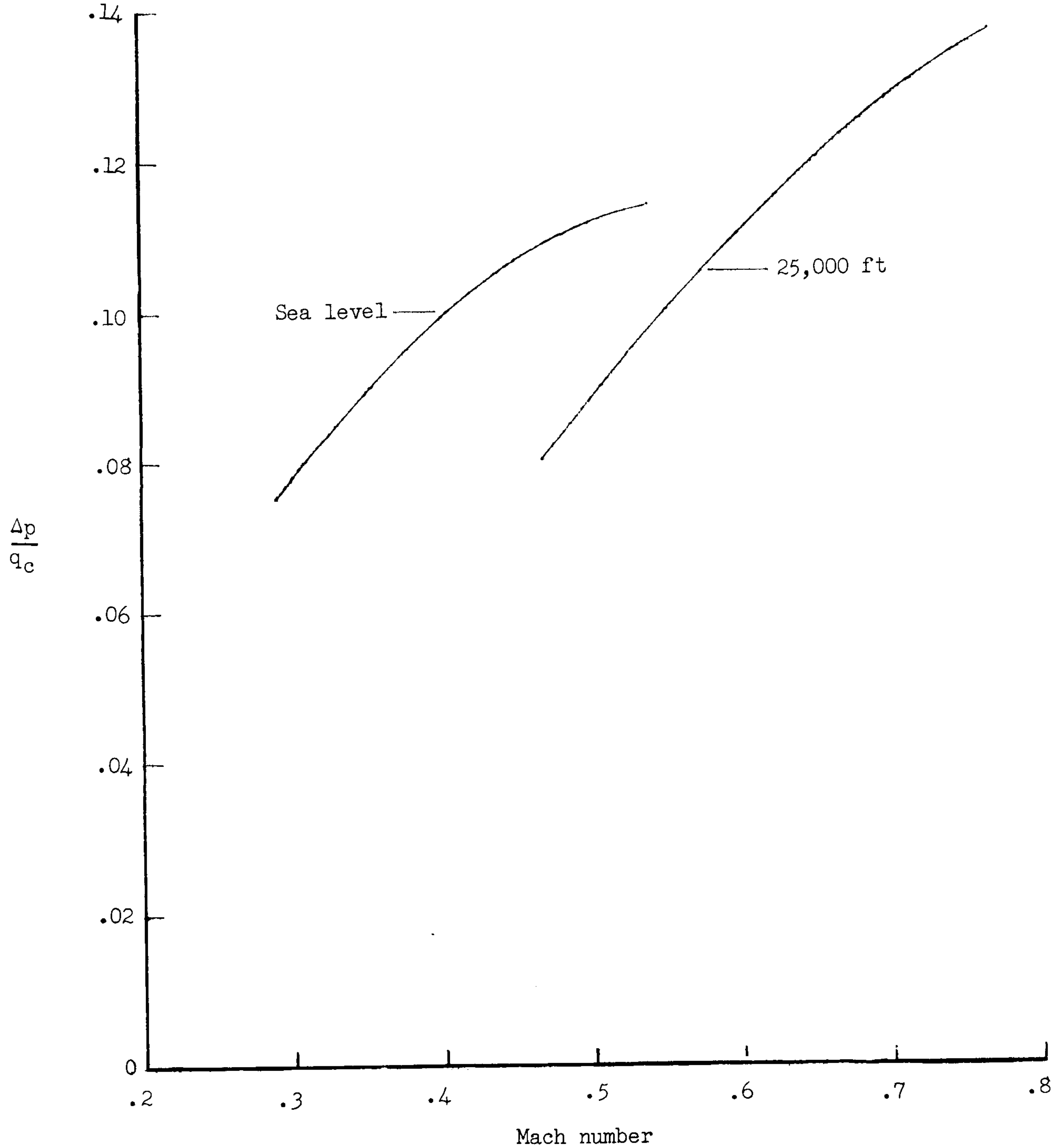


Figure 16.- Variation with Mach number of static-pressure error of pitot-static tube.

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